THE MECHANICAL ANALYSIS OF RADIAL TURBINES AND CENTRIFUGAL COMPRESSORS

1. Introduction

1.1 The mechanical analysis of Radial Turbines and Centrifugal Compressors has advanced considerably over the last years. Both components are more complex in shape than their axial flow counterparts and require a more complex method of analysis.

The object of this presentation is to review some of the developments which in the author's opinions are significant and to indicate the level of today's activities in this area. Inevitably such a review is somewhat superficial and an in depth treatment of some specific recent developments has to be omitted.

1.2 The initial attempts to analyse impellers were based on methods of analysis of thin discs. These methods had been established for many years. For instance the well-known numerical procedure by Grammel, for the calculation of discs of any profile and temperature distribution, dating from 1923, is still given as the recommended method by Loffler in 1960 (Ref. 1).

The adaptation of the thin disc analysis to radial flow components is, however, not very satisfactory, since differences between axial and radial flow components are very fundamental.

The availability of digital computers has meanwhile opened up possibilities of new methods, which can take the particular mechanical features of these components more realistically into account.

There is a large variety of possible geometries. To simplify this discussion, two representative geometries will be assumed only, one for the radial turbine (fig. a1) and the other for the centrifugal compressor (Fig. a2).

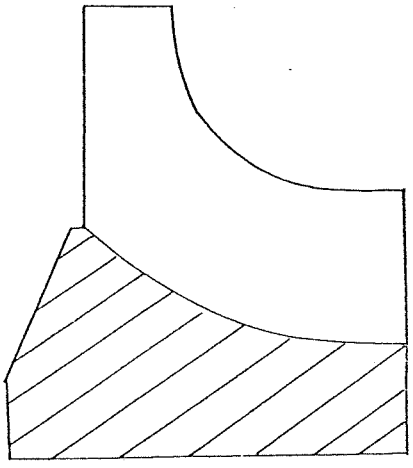

Fig. a1

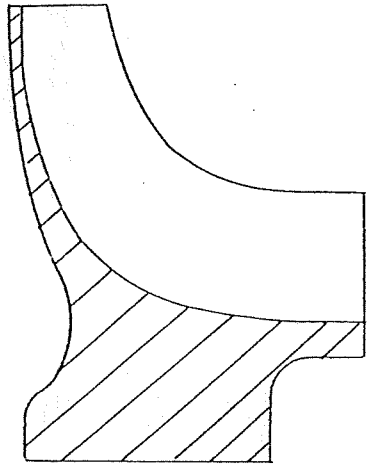

Fig. a2

The main characteristics of these two categories are

1. Radial Turbine

   Aerodynamic design concentrates on hub and shroud shapes and total flow passage area. Blade shape is not aerodynamically critical and can be optimized to a great extent. Backplate may or may not be scalloped between the blades. Number of blades can be fairly small < 15.

   Temperatures and tipspeed are high.

2. Centrifugal Compressors

   Blade shape is aerodynamically critical. Backplate usually extended to tip of blade.

   Number of blades large > 20.

   Temperatures low and tipspeed moderate, although increasing with development of higher pressure ratios.